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Anatomical Variations in the Female Pelvis: Their Classification and Obstetrical Significance

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SIX years ago one of us [W. E. C.] instituted, at the Sloane Hospital for Women, an investigation of the influence of pelvic size and shape upon the mechanism of labour. From clinical experience it seemed apparent that certain pelvic abnormalities not adequately described in obstetrical texts played an important part in the cause of dystocia and increased the difficulty in operative delivery. We believed that if the obstetrician could appreciate the size and shape of the pelvis, it would be possible to predict the type of difficulty which might occur in labour, or to terminate the labour with less trauma to the mother and child by the use of mechanical procedures applicable to the individual case. The results of this investigation, which are briefly reviewed in this report, have proved the correctness of our original contention [1–8].

During the early months our study was directed to the large collection of skeletal material at the American Museum of Natural History, New York; the U.S. National Museum, Washington; the Hanna Museum of Western Reserve University, Cleveland; and the Department of Anatomy, College of Physicians and Surgeons, New York. It soon became apparent that the accepted obstetrical classification of pelves failed to give a true concept of the marked variation in pelvic shape which existed in skeletal material. This suggested the need for roentgenologic study of the pelvic form in living women. Hitherto no use had been made of roentgen methods of examination at the Sloane Hospital so far as pelvic shape or size was concerned. A review of the literature pointed to the use of a frame method which would outline the superior straight by the use of the semi-sitting position. This method was used in two trial cases, but the results were not satisfactory, as distortion and the lack of bone detail in the lower pelvis prevented the adequate visualization of pelvic shape which the study of skeletal material had shown to be desired. Dr. Ross Golden and Dr. Paul C. Swenson, of the Roentgen-ray Department of the Presbyterian Hospital, were consulted, and acquainted with our difficulties and our objectives. The use of stereoroentgenograms was advised, and we were thereby gratified with the three-dimensional visualization of the pelvic cavity from the inlet to the outlet. Thus, by means of a roentgenological examination, it became possible to study in conjunction with skeletal material the variations in pelvic shape in living women.

Patients who had encountered major difficulty during labour were asked to report from the post-partum clinic for roentgenologic examination, and in a short time all the various types of extreme variation in pelvic shape observed in skeletal material were found in living women. Since complete details of the difficulties encountered in the operative delivery of these patients were available, it was possible to correlate these difficulties with the size and shape of each pelvis and to demonstrate that, in certain instances, the operator had attempted an obstetrical manœuvre which was

resisted by the particular shape of the pelvis. It thus became apparent that if an acceptable classification of pelvic shape could be devised, a practical and new diagnostic approach could be made to the study of the mechanism of labour.

During the latter part of the investigation the mechanism of labour was studied by a roentgenological examination during labour. This method permitted a study of the adjustment of the head to the particular shape of the individual pelvis and revealed its axis of descent. It was possible, in many instances, to obtain a roentgenologic examination just before the termination of the labour by some form of operative delivery. These films became invaluable records of the rôle played by pelvic type from the standpoint of the proper level at which to effect anterior rotation in examples of transverse or occipito-posterior arrest of the head, and enabled us to suggest the proper position in which the head should descend through the lower pelvis. This knowledge also enabled us to develop accuracy in the prediction of the probable mechanism of labour with each particular pelvic shape.

The main results of our investigations may be dealt with under the following heads :—

(1) The technique of pelvioradiography.
(2) The classification of the female pelvis from the standpoint of morphology.
(3) The mechanism of labour common to all pelvic types.
(4) The relation of pelvic shape to head position at the pelvic brim.
(5) The practical significance of pelvic shape in relation to recognized obstetrical manœuvres :—

A. Influence of pelvic type in forceps technique.
B. Transverse arrests.
C. Posterior arrests.
D. Anterior arrests.
E. The pelvic outlet as influenced by lower sacral variations.

(6) Stillbirth and its relationship to the mechanism of delivery.

(1) The Technique of Pelvioradiography

Having demonstrated the superiority of stereoroentgenograms in portraying the morphology of the pelvis, we realized that certain improvements in the technique of obtaining the films and in their visualization in the stereoscope would increase the practical value of the examination. For instance, it was found that in the ordinary stereoscope it was possible to vary the size of the stereoscopic image markedly by slight changes in the angle of the reflecting mirrors. As a result it was difficult to determine the true size of the pelvis, even though its shape was accurately reproduced. While experimenting with methods to enable us to observe a true pelvic image, we conceived the idea of recording the cardinal diameters of the pelvis by carrying a measuring ruler into the pelvic image directly under stereoscopic vision. Further experimentation proved the practicability of this method, which in itself was already known as the measurement of the " phantom image ". The principle was originally suggested by Deville [9]. Later, Trendelenburg [10], Pulfrich [11], and others, devised complicated stereoscopes which, though accurate, were not practical for general use. Accordingly we devised a special stereoscope and made certain additions to the technique of taking stereoroentgenograms to ensure the correct placement of the films in the viewing-box of the stereoscope. This latter objective was accomplished by the use of a casette frame (fig. 1) which marks the periphery of the film with the image of arrow markers, for placement over corresponding lines on the celluloid edge of the viewing surface. The optical system was equipped with rhomboids to adjust for variations in individual interpupillary distances. The full-silver surfaced mirrors were replaced by half-platinized mirrors, to allow direct measurement of the " phantom image " under stereoscopic vision. The finished

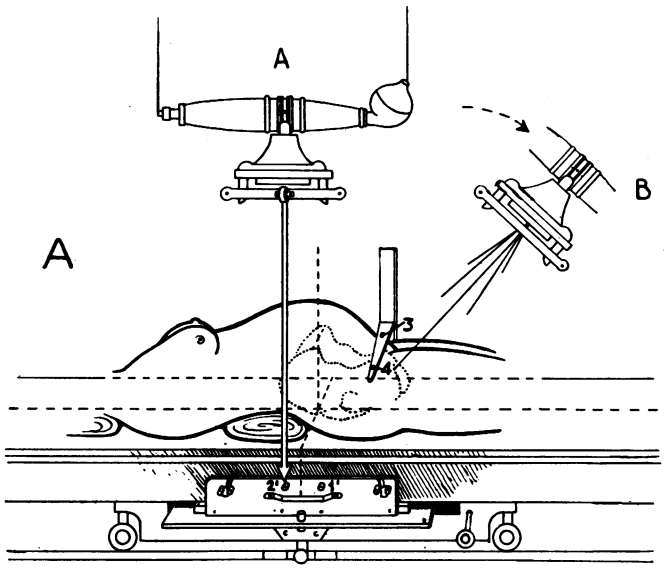
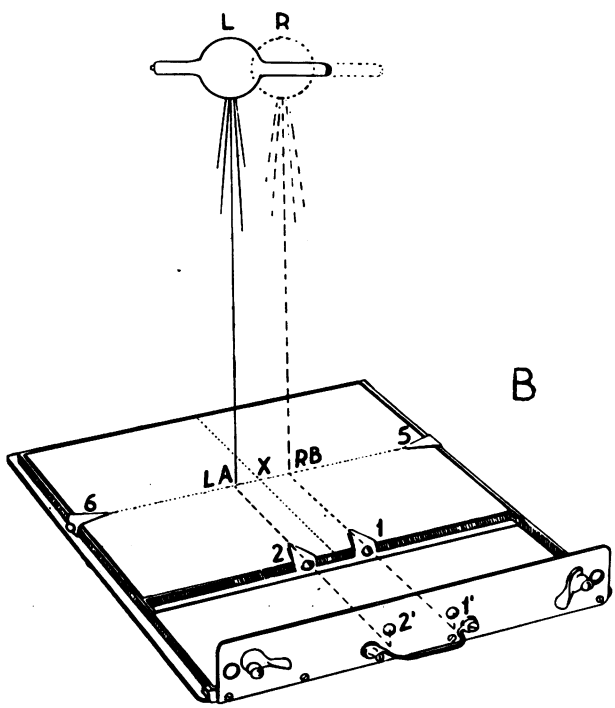


FIG. 1.—THE TECHNIQUE OF PELVIC RADIOGRAPHY

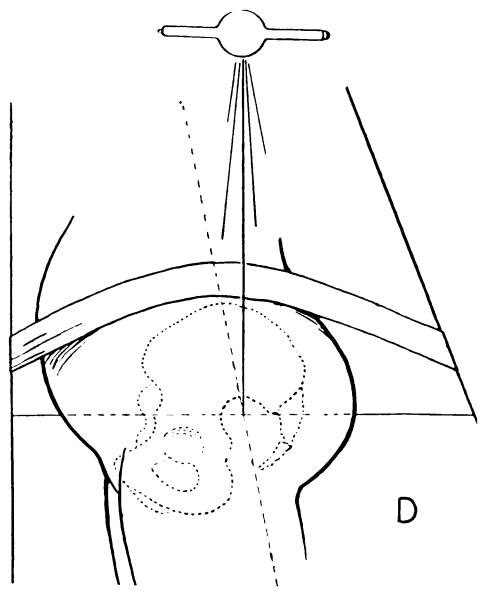
A. The patient supine on the X-ray table with the lumbosacral pad in place. The target is centred just above the mid-point of the line joining the anterior-superior iliac spines. Known marker 3 and 4 is suspended just free of the abdomen above the symphysis. B—A 45° angle view of the subpubic arch.



B. The casette frame to mark the films for placement in the viewing box of the precision stereoscope (fig. 1 c). The casette frame is placed over the casette on the casette tray and fixed by lugs to the side of the X-ray table (*see* fig. 1 A 1′ and 2′). With each shift the target moves along the line joining 5 and 6. For each exposure the target bears a perpendicular relationship to either 2 and 2′ or 1 and 1′.

model is called a *Precision Stereoscope*, because by its use the trained observer can carry an ordinary measuring rule into the pelvic image and measure directly any desired pelvic diameter at any level in the pelvis. One objective of the investigation was thus accomplished—namely a roentgenologic technique giving a three-dimensional

C. The viewing surface of the precision stereoscope. The image of the arrow-tips 5 and 6 and 2 and 1 (fig. 1 B) are made to superimpose over corresponding lines marked on the celluloid edge of the viewing box.



D. Lateral view of the pelvis. Target-film distance 36 in.

image of pelvic shape and of the relationship of the head to the pelvic inlet and at the same time enabling the observer to measure the cardinal pelvic diameters, fig. 1C. In each instance a lateral film of the pelvis is obtained and also a view of the subpubic arch (fig. 1, A and D).

(2) The Classification of the Female Pelvis from the Standpoint of Morphology

At first the inspection of skeletal material revealed such marked variations in the shape of the pelvic inlet that a classification according to type did not seem feasible, but with greater experience in the study of pelvic morphology, it became evident that certain pelves conformed to one of four characteristic inlet shapes, namely, the *long narrow oval*, the *round*, the *flat*, and the *wedge-shaped* types. A large number of pelves appeared to conform to intermediate shapes between these extreme types. It seemed advisable to consider these four characteristic extreme shapes as standard or parent types and to devise a terminology which would not only designate these types but would be flexible enough for combinations with each other to designate the equally important borderline forms.

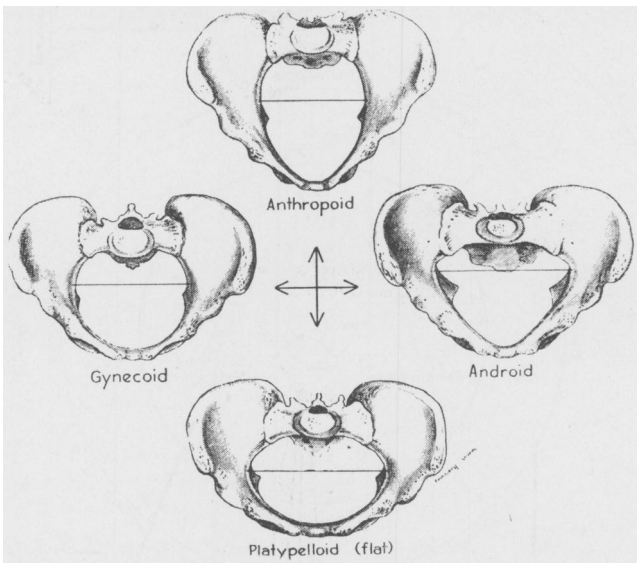


Fig. 2.—The Four Classical Pelvic Types

The four standard or parent types divided into an anterior and posterior segment by a coronal plane passing through the widest transverse diameter and the interspinous diameter. In the illustration only the widest transverse diameter is shown.

A review of the literature revealed that Weber [12] in 1830, and von Stein [13] in 1844, had recognized these four groups but had not considered the borderline types. Turner [14], in 1885, described three of these four groups but failed to suggest the wedge-shaped type and, like Weber and von Stein, did not attempt the classification of the borderline groups. The long narrow oval type appeared to resemble the pelvis of the anthropoid apes, and Turner, considering this type a primitive form, had shown it to be more commonly found in primitive races. The round type conformed to the classical female pelvis. The wedge-shaped pelvis simulated the appearance of the male pelvis. Berry Hart [15] recognized and described this type as the sexually inverted pelvis. The flat pelvis, though frequently confused with the wedge-shaped form, presented no difficulty of recognition to these earlier workers. All this information enabled us to suggest the following terminology for these four standard types (fig. 2) :—

(1) The anthropoid type, resembling the long, narrow, oval pelvis of the anthropoid ape.

(2) The gynecoid type, showing all the well-known architectural characteristics of the normal female pelvis.

(3) The platypelloid type. This pelvis has a wide or transverse oval appearance.

(4) The android type, which bears a morphological resemblance to the human male pelvis. The inlet is wedge-shaped or blunt heart-shaped.

The use of one of these terms by itself indicates a parent pelvic type in which the combined shape of the anterior and posterior segment conforms to the classical longitudinal oval (anthropoid), the round (gynecoid), the transverse oval (platypelloid), or the wedge-shaped (android) type of inlet. Many pelves are, in shape,

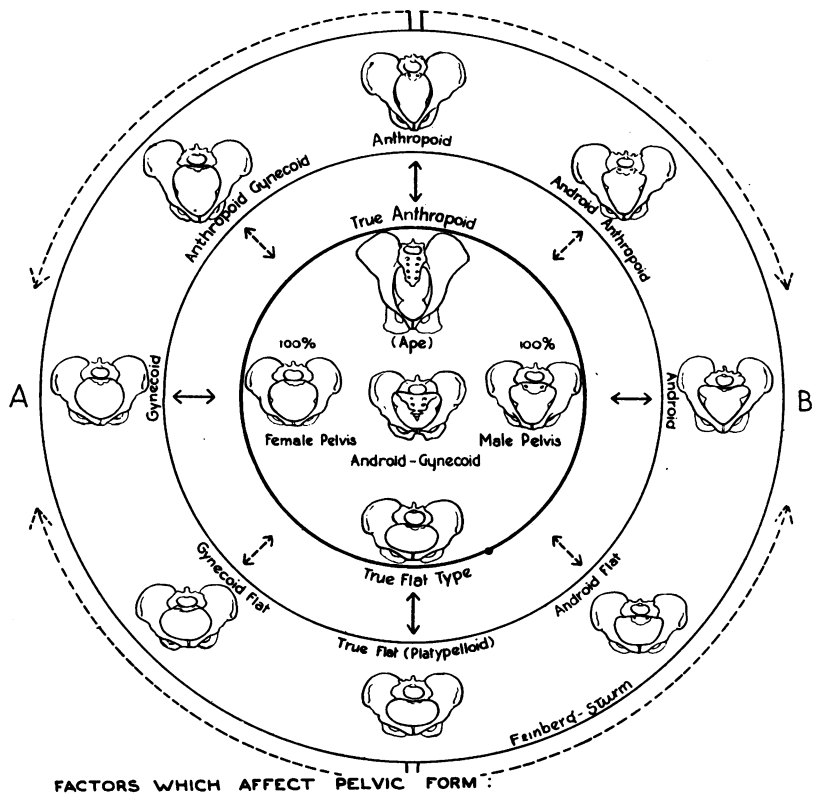


FIG. 3.—THE FOUR CLASSICAL TYPES AND INTERMEDIATE FORMS

The complete classification showing the relationship of borderline or mixed pelvic types to the standard or parent forms. Observe the transition in pelvic shape from a long narrow oval (anthropoid) through the round (gynecoid) to the flat (platypelloid) form. Pelves with masculine characters may also show a similar cycle of change.

A. Evolutionary—transition from the long oval (anthropoid) to the flat type (vertical axis).

B. Sexual—overlap of masculine characters from the gynecoid to extreme android type (trans-axis) and within the evolutionary cycle.

borderline types containing characteristics of each of these four parent groups. In the analysis and description of these we have found that great help is obtained if we divide the pelvis into an anterior and posterior segment not only at the outlet, as is commonly done, but also at the inlet and in the cavity. This division is accomplished by passing a coronal plane through the widest transverse diameter of the inlet and

the interspinous diameter. The posterior segment may conform in shape to one standard type and the anterior segment to another. By suitable combinations the terminology suggested for the parent forms may be used to describe these borderline types. The first term describes the shape of the posterior segment and the second term indicates the shape of the anterior segment. Thus the term " anthropoid-gynecoid " is intended to designate a borderline type between the anthropoid and gynecoid type which is a long *wide* oval in shape. The " gynecoid-flat " is a normal pelvis with a *flat tendency* at the inlet. The " anthropoid-gynecoid " and " gynecoid-flat " borderline types, *along with their respective parent forms*, denote a cycle of change in pelvic form from the longitudinal narrow oval through a round type to a transverse oval or flat shape, fig. 3.

Certain mixed types of pelves may show in addition masculine characteristics in the posterior pelvis, as evidenced by a narrow sacrosciatic notch or a narrow fore pelvis to form a *long narrow wedge-shaped* inlet, a *flat wedge-shaped*, or a *blunt-heart-shaped* inlet. These borderline android forms are described by the terms " android-anthropoid ", " android-flat ", or " android-gynecoid ".

The term " platypelloid ", originally suggested by Sir William Turner, is too cumbersome for general use. Accordingly it is used to designate the flat group of pelves which show variable degrees and types of flattening at the inlet, such as the " gynecoid-flat ", the " android-flat ", and the " true flat pelvis ".

Below the pelvic inlet the shape of the pelvic cavity may change, as the outlet is approached, through variations in the splay of the side walls and the curvature and inclination of the sacrum and symphysis. A decrease in transverse capacity may be caused by convergence of the side walls or variations in the length of the ischial spines. The subpubic arch may be wide, moderate, or narrow, but the size of the arch may or may not vary directly with the degree or type of side-wall convergence. As a result a narrow subpubic arch may be associated with a wide intertuberous diameter, or, on the other hand, an equally narrowed subpubic arch may be found with a narrow intertuberous and interspinous diameter (fig. 4).

Variations in the transverse and longitudinal curvature and in the inclination of the sacrum have as important effects on lower posterior pelvic capacity as the character of the side walls and the subpubic arch have upon anterior pelvic capacity. The inclination of the sacrum is shown by the angle subtended between the plane of the inlet and the surface of the upper two or three sacral segments. The inclination may be forward, average, or backward (fig. 4). A line drawn from the ischial spines to the sacrum, parallel to the plane of the inlet, gives an index of posterior pelvic capacity at that level. (Posterior sagittal diameter of the second parallel plane.) The lower sacral region, along with the coccyx and its ligamentous supports, forms a platform under the ischial spines, the so-called sacrococcygeal platform. From the practical standpoint it is important to gain information relevant to the level of this region to the spines and the position of the sacral tip in relation to the ischial spines. (Posterior sagittal diameter of the third parallel plane, fig. 4.) The practical significance of the forward or backward sacral inclination and forward or backward sacral tip, with variations in the level of the sacrococcygeal platform to the ischial spines, will be discussed by means of suitably chosen case studies.

All these anatomical variations can be determined with fair accuracy by clinical examination of the pelvis. The clinician carefully palpates the subpubic arch, determines the slope of the side walls down to the ischial tuberosities, and notes the character of the ischial spines and the relationship of the sacrococcygeal platform to the ischial spines. At higher levels the upper sacral region or sacral promontory may be palpable. Under such circumstances the application of the facts gained from the palpation of the lower pelvis to the supposed shape of the inlet will reveal the pelvic type within a practical degree of accuracy. The clinical recognition of a pelvic abnormality justifies a roentgenologic examination, in order that the obstetrician may

gain a detailed knowledge of the shape and size of the pelvic cavity in each individual case.

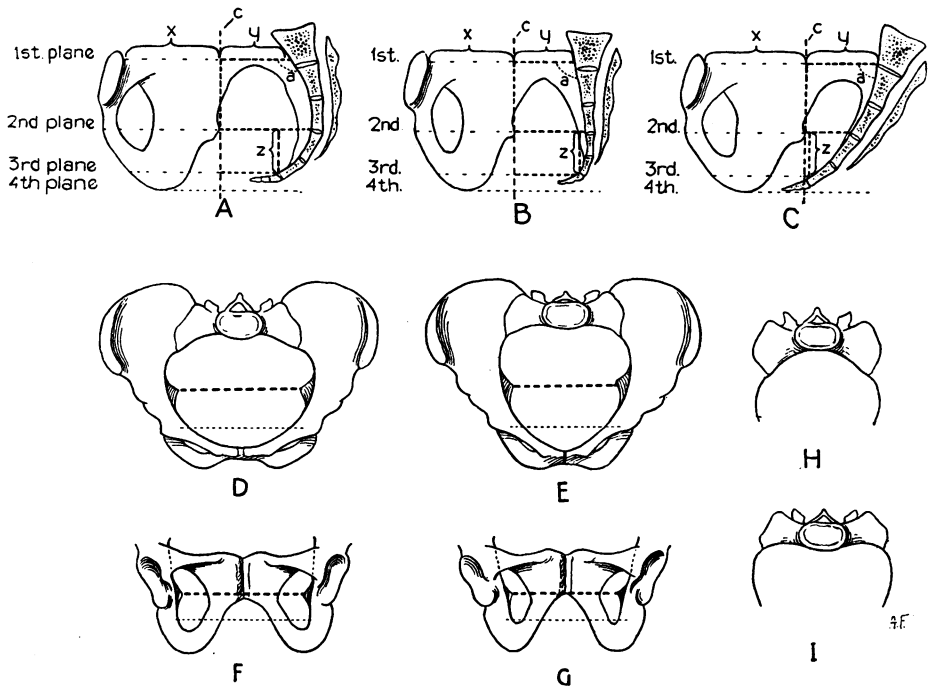


FIG. 4.—VARIATIONS IN THE LOWER PELVIS AS RELATED TO THE PELVIC INLET

c = a coronal plane through the widest transverse diameter of the inlet and the interspinous diameter divides the pelvic cavity into an anterior and a posterior segment.

x = anterior sagittal diameter at inlet and to lower levels.

y = posterior sagittal diameter at inlet and to lower levels.

a = the inclination of the sacrum as indicated by the size of the angle subtended between the first parallel plane of the inlet and the surface of the upper two or three sacral segments.

A. Increased sacral curvature and backward sacral inclination. Note length of posterior sagittal diameter, " y " at the inlet (first parallel plane), at the level of the ischial spines (second parallel plane), and at the level of the sacral tip (third parallel plane). The fourth parallel plane denotes the lowest portion of the pelvic cavity at the ischial tuberosities. Observe level of sacro-coccygeal platform " z " to the ischial spines. (This description applies also to B and C.)

B. Straight sacrum, average sacral inclination.

C. Average curvature to sacrum ; forward sacral inclination.

D, E, F, and G. Case studies to show that equally narrowed subpubic arch views may be associated with pelves of different shapes. The pelvis of D and F shows a wide interspinous and intertuberous diameter. The pelvis of E and G shows a narrow interspinous and intertuberous diameter with converging side walls.

H. The transverse sacral concavity commonly found in anthropoid types.

I. The straight sacral edge commonly found in android and flat types.

We established the frequency of occurrence of the four standard types in skeletal material from the inspection of Professor Todd's fine collection of sexed pelves at Western Reserve University. The borderline forms were included in the nearest related standard type (Table I).

TABLE I

Type	Female white %	Female negro %
Anthropoid	23·5	40·5
Gynecoid	41·4	42·1
Platypelloid	2·6	1·7
Android	32·5	15·7
No. of cases	147	121

The anthropoid type, as Turner pointed out, is more commonly found in the negro race. The android type is more frequently observed in the white race. The platypelloid type, though rare, is twice as common in the white race as in the black.

The frequency of occurrence of these pelvic types varies according to race, to constitutional habitus or selection of groups within each race, and to familial and other inherited characteristics.

SUMMARY OF CLASSIFICATION AND DESCRIPTION OF THE PELVIS

I. The anthropoid type (pure or parent type)—large, average, or small.
II. Intermediate or mixed types between the anthropoid and gynecoid types—large, average, or small : anthropoid-gynecoid type.
III. The gynecoid type (pure or parent type)—large, average, or small.
IV. Intermediate or mixed types between the gynecoid and platypelloid (flat) types—large, average, or small : gynecoid-flat type.
V. The platypelloid type (pure or parent type)—large, average, or small.
VI. The android type (pure or parent type)—large, average, or small.
VII. Intermediate or mixed android types—large, average, or small : (*a*) android-anthropoid ; (*b*) android-gynecoid ; (*c*) android-flat.
VIII. Asymmetrical pelves.
IX. The pathological pelvis (rickets, osteomalacia, congenital anomalies, and deformities due to sacro-iliac and spinal disease), &c.

In addition to a complete description of the pelvic cavity from inlet to outlet, the lengths of the cardinal pelvic diameters should be given, as obtained by roentgen pelvimetry : as, for instance, the true conjugate diameter, the widest transverse diameter of the inlet, the interspinous and the intertuberous diameter. The intertuberous diameter may be obtained by the precision stereoscope, since the widest space just above the tuberosities of the ischium is easily located.

In each individual pelvis the following regions of the lower pelvis must be described in detail :—

(*a*) Subpubic arch—wide, moderate, narrow.
(*b*) Pubic rami—straight or curved. (Gothic or Norman arch effect.)
(*c*) Splay of side walls—divergent, straight, or convergent.
(*d*) Fore pelvis—well formed or funnel-shaped.
(*e*) Character of the ischial spines—long and narrow, or flat on a broad base.
(*f*) The sacrosciatic notch—wide, average, or narrow masculine type.
(*g*) The sacrum—a general concept of length, width, curvature, and number of segments.
(*h*) Sacral inclination—forward, average, backward.
(*i*) Lateral bore—straight, convergent, or divergent.
(*j*) The posterior sagittal diameter, at the inlet, at the level of the ischial spines and at the level of the sacral tip and the relationship of the sacrococcygeal platform to the plane of the ischial spines.
(*k*) Shape of the outlet in front of the sacral tip.

Finally the pelvis should be studied as a whole, to determine whether it is well formed or angular, irrespective of the gynecoid, android, anthropoid, or flat character of the pelvic inlet.

(3) THE MECHANISM OF LABOUR COMMON TO ALL PELVIC TYPES

As soon as the marked variation in pelvic shape had been noted and a classification of pelves devised, the roentgenological method of examination was used extensively during labour to study the position and axis of descent of the head in relation to the

pelvic cavity at various levels. Attention was first directed to engagement and descent.

The act of engagement in normal labour is illustrated diagrammatically in fig. 5 A and B. In most cases engagement begins with the head assuming a moderate degree of asynclitism or showing a tendency towards a posterior parietal presentation. The posterior parietal bone overhangs the inlet with the sagittal suture directed downward and forward. The anterior parietal bone descends behind the symphysis in a *downward and backward direction* until the head is fitting squarely in the pelvic canal. The lower uterine segment and cervix, while dilating in active labour, serve as a guiding factor during engagement. Scant reference has been made in recent obstetrical literature to the importance of this factor. Barnes [16] described the principle quite accurately by stating that the anterior aspects of the lower uterine segment acted

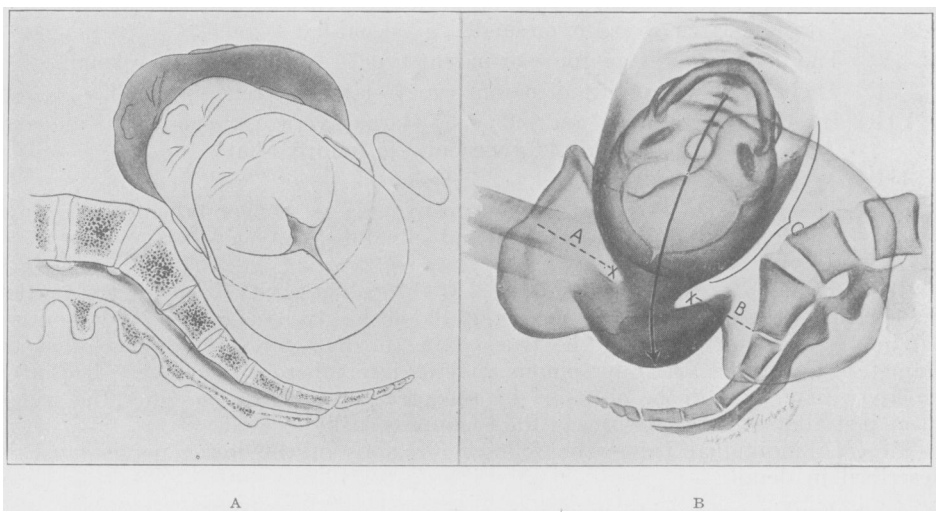


FIG. 5.—ENGAGEMENT OF THE HEAD WITH VARIATION IN THE POSITION OF THE AXIS OF DESCENT.

A. Common mechanism of engagement. The posterior parietal bone overhangs the inlet with the sagittal suture directed downward and forward. The anterior parietal bone descends behind the symphysis in a downward and backward direction following a curved axis of descent.

B. The method of engagement illustrated in fig. 5 A takes place along the axis of the curved area. Variations in the length of AX and BX may bring about descent close to the symphysis or to the sacrum.

as a " valve " or " inclined plane " directing the head downward and backward. Parvin [17] and others inferred the mechanism when they spoke of a " dynamic " axis of descent caused by soft parts which did not always correspond with the so-called " static " axis of the pelvis itself.

The roentgenologic study of the fœtal pelvic relationships during labour shows also marked variations in the position of the axis along which this act of engagement takes place (fig. 5 B). A decrease in the length of AX brings about descent of the head close to the symphysis. A decrease in the length of XB causes descent to occur close to the sacrum. Therefore the position of the head may vary according to the shape of the segment through which it descends. The cause for these variations in axes of descent is open to speculation. In certain instances abnormalities in pelvic size and shape may be the causative factor. In others the length, strength, or character of the supports of the lower uterine segment and the cervix may force the head to descend through the fore pelvis or through the posterior pelvis.

(4) The Relation of Pelvic Shape to Head Position at the Pelvic Brim

This was studied by means of stereoroentgenograms and lateral views of the pelvis obtained early in labour in approximately 200 unselected cases. The observations are shown in Table II.

Table II

	Posterior oblique position %	Transverse position %	Anterior oblique position %	Direct occipito-anterior position %	No. of cases
Anthropoid	28·5	37·5	17·0	17·0	59
Gynecoid	10·0	69·0	20·0	1·0	81
Android	20·5	71·0	8·5	0·0	59
Combined	18·5	60·0	16·0	5·5	
				Total	199

Most obstetrical texts state that the oblique anterior position is more commonly found at engagement than either the transverse or oblique posterior position. This table shows, however, that transverse positions are three times as common as the other positions. The influence of pelvic shape at the inlet is also shown. In gynecoid and android types transverse positions occur in approximately 70% of the cases. In anthropoid types the long narrow inlet causes a decrease in transverse positions (37·5%) and a marked increase in anterior positions (34%) and posterior positions (28·5%). The head must descend and engage before the shape of the inlet can exert the maximum influence upon its position. During engagement, however, it is not unusual to observe partial rotation as the head adjusts itself to the shape of each particular pelvis. At lower levels a roentgenological examination obtained later in labour has shown that partial rotation from the transverse to the posterior position may occasionally occur if the shape of the lower pelvis creates increased capacity in the sacral hollow, or if the fore-pelvis becomes narrow by converging side walls. As a rule, however, in spontaneous deliveries, the position assumed by the head at engagement is maintained to a low level in the pelvis before anterior rotation begins. Thus the transverse position in android and flat pelves represents a physiologic position for these particular pelves. Likewise, the oblique anterior and posterior positions may be considered normal for the anthropoid pelvis.

In a case of arrest it is evident that a knowledge of pelvic shape will enable the obstetrician to determine whether it is advisable to maintain the position of arrest to lower levels, to rotate at the level of arrest, or to elevate and rotate at higher levels in the pelvis.

(5) The Practical Significance of Pelvic Shape in Relation to Recognized Obstetrical Manœuvres

Obstetrical prognosis and the management of labour depend upon a number of factors, the more important of which deal with the questions of whether the head *will* descend and of *how* the head descends. The question of whether the head *will* descend concerns the problem of disproportion between the size of the head and the pelvic inlet. Disproportion between the head and the pelvis, to even a major degree, is occasionally observed in spontaneous deliveries, especially in multiparous women. The incidence of variable degrees of disproportion increases in the low forceps, low-medium and medium forceps, and Cæsarean section groups. The disproportion, in most instances, can be readily observed from the study of the stereo-roentgenograms in the precision stereoscope by visually attempting to compare the head and its biparietal diameter with the available space present at the inlet or in the lower pelvis. The observer experienced in the use of the precision stereoscope can actually measure one or more cardinal diameters of the fœtal head, besides noting the amount of clearance between the head and the pelvis. Flexion and moulding of the head in

labour decrease head size and represent such variable factors that attempts to reduce the degree of existing disproportion to simple mathematical terms have not given satisfactory practical results. Although a roentgenological examination may reveal the pelvic type and the presence of a large head, a trial of labour becomes the best means for determining the correct significance to place upon this supposed degree of disproportion.

The question of *how* the head descends when the pelvis is abnormal has considerable practical significance, especially in regard to the ease or difficulty encountered in the use of certain recognized obstetrical manœuvres, either manual or instrumental.

The influence of pelvic type on the method employed for delivery is shown in Table III.

TABLE III.—DISTRIBUTION OF PELVIC TYPES ACCORDING TO THE METHOD OF DELIVERY.

							Platypelloid				
	Anthropoid	Anthropoid-gynecoid	Android-anthropoid	Gynecoid	Android	Android-gynecoid	Gynecoid-flat	Android-flat	True-flat	Rachitic-flat	No. of cases
Spontaneous	10	15	9	37	10	8	5	4	2	0	100
Low forceps	16	15	10	32	16	5	3	2	1	0	100
Low-mid forceps	13	10	12	12	21	14	5	9	4	0	100
Mid forceps	12	2	12	15	35	9	6	8	1	0	100
Cæsarean section	11	5	9	12	41	7	3	6	2	4	100
									Total	..	500

The most significant fact revealed by this table is the frequency of spontaneous deliveries in the gynecoid forms and the frequency of forceps deliveries and Cæsarean section in the android forms. The efficiency of the anthropoid pelvis is demonstrated by the decrease in incidence of this type and its borderline forms from the spontaneous to the Cæsarean section group. In 500 cases four rachitic flat pelves were noted, all in the Cæsarean section group.

Average measurements on a group of anthropoid, gynecoid, or flat pelvic types will show a ratio between the antero-posterior and the widest transverse diameters which indicates a long narrow oval, a round, or a transverse oval shape. The characteristic wedge-shaped appearance of the android type, however, is not shown by the ratio between these diameters. Accordingly no attempts were made to compute average measurements, since the results would not be significant in revealing pelvic shape.

The smaller the pelvis, the greater is the chance of obstetrical difficulty. This well-known fact is evident in Tables IV to VIII, which show an increased frequency of small diameters from the spontaneous to the Cæsarean section group. But the high frequency of small diameters in low-medium and medium forceps cases shows that small diameters do not preclude the possibility of safe delivery through the natural passages. Safe delivery under such circumstances may depend upon the efficiency of the forces of labour or the use of mechanical skill in operative deliveries when the pelvis is abnormal. It is for this reason that interest is directed toward pelvic shape in relation to recognized obstetrical manœuvres.

Tables IV to VIII also show that pelves of various types may be associated with a small pelvic diameter. Flat pelves with an antero-posterior diameter of 10 cm. are

TABLE IV.—DISTRIBUTION OF SMALL DIAMETERS ACCORDING TO PELVIC TYPES IN 100 CASES OF SPONTANEOUS DELIVERIES OF THE AVERAGE SIZE CHILD (3,200 GRM.).

							Platypelloid			
	Anthropoid	Anthropoid-gynecoid	Android-anthropoid	Android-gynecoid	Gynecoid	Android	Gynecoid-flat	Android-flat	True-flat	Number of cases
A.P. diameter of 10 cm. or under	0	0	0	0	0	1	2	0	1	4
Interspinous diameter of 10 cm. or under	7	2	4	1	2	2	0	0	0	18
Transverse less than 12 cm.	2	0	0	0	0	0	0	0	0	2

TABLE V.—DISTRIBUTION OF SMALL DIAMETERS ACCORDING TO PELVIC TYPE IN 100 CASES OF LOW FORCEPS DELIVERIES.

							Platypelloid			
	Anthropoid	Anthropoid-gynecoid	Android-anthropoid	Android-gynecoid	Gynecoid	Android	Gynecoid-flat	Android-flat	True-flat	Number of cases
A.P. diameter of 10 cm. or under	0	0	0	0	0	0	2	2	1	5
Interspinous diameter of 10 cm. or under	11	4	5	1	1	10	0	0	0	32
Transverse less than 12 cm.	3	1	1	1	0	1	0	0	0	7

TABLE VI.—DISTRIBUTION OF SMALL DIAMETERS ACCORDING TO PELVIC TYPE IN 100 CASES OF LOW-MID FORCEPS DELIVERIES.

							Platypelloid			
	Anthropoid	Anthropoid-gynecoid	Android-anthropoid	Android-gynecoid	Gynecoid	Android	Gynecoid-flat	Android-flat	True-flat	Number of cases
A.P. diameter of 10 cm. or under	0	1	0	2	0	0	2	5	1	11
Interspinous diameter of 10 cm. or under	9	7	7	6	1	12	2	4	0	48
Transverse less than 12 cm.	5	3	3	1	0	0	0	0	0	12

TABLE VII.—DISTRIBUTION OF SMALL DIAMETERS ACCORDING TO PELVIC TYPE IN 100 CASES OF MEDIUM FORCEPS DELIVERIES.

							Platypelloid			
	Anthropoid	Anthropoid-gynecoid	Android-anthropoid	Android-gynecoid	Gynecoid	Android	Gynecoid-flat	Android-flat	True flat	Number of cases
A.P. diameter of 10 cm. or under	0	0	1	2	0	2	2	3	0	10
Interspinous diameter of 10 cm. or under	6	3	8	6	4	17	0	1	0	45
Transverse less than 12 cm.	5	0	2	0	0	1	0	0	0	8

TABLE VIII.—DISTRIBUTION OF SMALL DIAMETERS ACCORDING TO PELVIC TYPE IN 100 CASES OF DELIVERY BY CÆSAREAN SECTION.*

							Platypelloid				
	Anthropoid	Anthropoid-gynecoid	Android-anthropoid	Android-gynecoid	Gynecoid	Android	Gynecoid-flat	Android-flat	True-flat	Rachitic-flat	Number of cases
A.P. diameter of 10 cm. or under	0	2	2	1	4	15	1	6	0	4	35
Interspinous diameter of 10 cm. or under	9	2	6	1	6	27	0	2	0	0	53
Transverse under 12 cm.	6	1	2	0	1	5	0	0	0	0	15

* In Tables IV to VIII the increased frequency of narrow diameters from the spontaneous to the Cæsarean section group indicates that the pelvis also decreases in size. In the tables many pelves had more than one small diameter.

commonly found in the spontaneous and low forceps group. However, certain android, gynecoid, anthropoid-gynecoid, or android-anthropoid types may have an equalled narrowed antero-posterior diameter but may require medium forceps or Cæsarean section to effect delivery. The same principle is noted when a small interspinous diameter is compared to pelvic type and the method employed for delivery. Certain anthropoid types with a small interspinous diameter are found in the spontaneous and low-forceps groups. But the android pelvis is commonly associated with an equally narrowed interspinous diameter in the medium-forceps and Cæsarean-section groups. In anthropoid types the long antero-posterior diameter may compensate for the narrow interspinous diameter, but in android types there is less compensatory space in the sagittal plane or in other regions of the pelvis. These observations show that as pelvic form is so variable, any single small diameter is not an index of pelvic capacity. We believe the visual study of stereoroentgenograms is the best method of examining the pelvic architecture, since the narrowest diameter can be seen and measured and the compensatory space can be noted in other diameters.

(5A) *Influence of Pelvic Type in Forceps Technique*

It has been noted that in certain instances the head may descend through the posterior pelvis close to the sacrum, through the centre of the pelvis, or through the anterior pelvis close to the symphysis (fig. 5 B). During this present investigation no attempt has been made to determine the frequency of occurrence of these axes of descent. But in the spontaneous and the forceps group numerous instances showed that with efficient labour in an abnormal pelvis the head descends more easily through the ample posterior pelvis. In low-medium and medium arrest of the head, the proximity of the head to either the sacrum behind or the symphysis in front has complicated the mechanism of forceps delivery. Granted that the axis of descent may guide the head close to the symphysis or to the sacrum, it follows that arrest may occur with the head close to the symphysis in one case, or closer to the lower sacral region in another. For this reason it is suggested that when the position of arrest in relation to the symphysis or sacrum can be accurately ascertained by clinical or roentgenological methods of examination, the type of forceps operation should be classified as " low-medium or medium forceps through the anterior pelvis *in front* " or " low-medium or medium forceps through the posterior pelvis *behind* ", or by the use of some other equally descriptive term (fig. 6 A).

With arrest of the head in the transverse position, manual or instrumental anterior rotation brings about a mechanical advantage only if the shape of the upper pelvis will allow rotation, or if anterior rotation is advisable from the standpoint of the shape of the pelvis below the level of arrest (fig. 6 B).

The head may become arrested close to the symphysis or pubic rami in the position designated as "low-medium or medium forceps in the anterior pelvis". In these cases manual or instrumental methods should be used first to elevate the head and then to direct it slightly downward and backward and thereby avoid misdirected force with traction against the fore pelvis (fig. 6 D).

Most experienced obstetricians have encountered cases in which anterior rotation by manual or instrumental methods is difficult or impossible to accomplish. In such circumstances numerous manœuvres may be used with success—such as pelvic application of forceps to the transverse position, oblique application, or a cephalic application of Kielland forceps. In skilled hands good results are obtained by any of these manœuvres. We feel that stereoscopic examination of the pelvis has enabled us to choose the best method applicable to the particular case. In our clinic we have been favourably impressed by the use of Barton forceps [19] in the treatment of transverse arrest of the head (fig. 6 C). According to the type of pelvis, the Barton forceps may be used to rotate the head at the level of arrest or to effect descent to lower levels without rotation. If it is desirable to bring the head to a lower level in

the transverse position (low-medium or medium forceps in posterior pelvis *behind*, fig. 6 A), the head is made to descend by lateral flexion following the curve of the lower sacrum and sacrococcygeal platform. By this act the influence of the posterior pelvis is removed and anterior rotation can be easily accomplished on the inner aspects of the pubic rami or with the caput in sight below the subpubic arch.

The principle of descent advised for the treatment of transverse arrest of the head, and illustrated in fig. 6 C, may be applied to other positions of the occiput. The occipito-posterior position may be used as an example. In the discussion of the observations shown in Table II, we pointed out that the occipito-anterior and the occipito-posterior position seemed to be normal positions for the head to assume in anthropoid types for the same reason that platypelloid and android types favoured

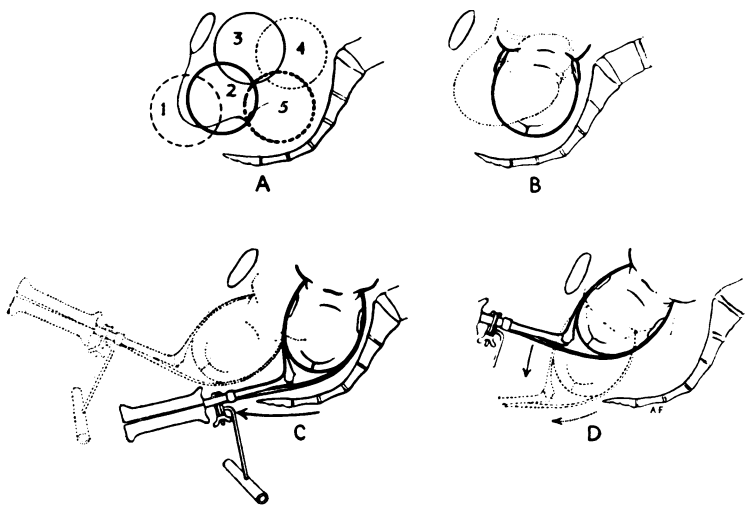


FIG. 6.—FORCEPS TECHNIQUE

A. Classification of forceps from the standpoint of level and axis of arrest.
1. Low forceps.
2. Low-medium in the anterior pelvis (in front).
3. Medium in the anterior pelvis (in front).
4. Medium in the posterior pelvis (behind).
5. Low-medium in the posterior pelvis (behind).

B. This diagram shows the mechanical advantage of anterior rotation from the transverse position if the shape of the pelvis will allow rotation. By anterior rotation the occiput approaches closer to the symphysis in the fore pelvis.

C. A head arrested in the transverse position in the posterior pelvis may be delivered to lower levels in the position of arrest by anterior lateral flexion. Barton forceps are applicable for this mechanism. The head is made to follow closely the curve of the lower sacrum and coccyx. Anterior rotation is accomplished on the inner aspects of the pubic rami or in the subpubic arch.

D. Arrest of the head may occur close to the posterior aspects of the symphysis and pubic rami. Forceps may be difficult to apply. The head is elevated and deviated slightly downward and backward as illustrated and later laterally flexed as in fig. 7 D.

descent in the transverse position. Accordingly in the treatment of arrest of the head in the occipito-posterior position, in certain instances it may be advisable for the obstetrician to bring the head to lower levels and effect rotation on the pelvic floor or occasionally, if the shape of the pelvis so demanded, to deliver face to pubis. In other instances the best manœuvre may be to elevate the head to a higher level and rotate there. This is especially true when the pelvis is of the anthropoid type with marked transverse narrowing throughout.

Let us amplify these general statements by a more detailed study of cases.

(5B) *Transverse Arrests*

In 48 cases out of 100 medium-forceps deliveries the head was found arrested in the transverse position. The type of pelvis associated with the particular obstetrical manœuvre employed to effect delivery is shown in Table IX. In 22 instances the

TABLE IX.—DISTRIBUTION OF PELVIC TYPE ACCORDING TO THE MANŒUVRE USED IN MID-PELVIS ARREST IN THE TRANSVERSE POSITION.
(48 *in* 100 *Cases of Mid Forceps.*)

							Platypelloid			
	Anthropoid	Anthropoid-gynecoid	Android-anthropoid	Android-gynecoid	Gynecoid	Android	Gynecoid-flat	Android-flat	True-flat	Number of cases
Barton's, pelvic or cephalic application in the O.T. with traction to pelvic floor followed by low rotation	0	1	1	4	2	7	2	5	0	22
Anterior rotation with forceps at level of arrest	0	1	4	0	1	4	2	0	0	12
Manual rotation to oblique anterior position with delivery by pelvic curved forceps	1	0	0	0	1	3	0	1	0	6
Spiral anterior rotation by forceps	0	0	0	1	1	5	0	0	0	7
Elevation with anterior rotation and forceps	0	0	0	0	0	0	1	0	0	1
								Total	..	48

delivery was accomplished by the cephalic application of forceps (usually Barton forceps) to the transverse position, with lateral flexion, descent to the pelvic floor in the same position, and low anterior rotation. Two types of pelves are characteristically responsible for the ease of this mechanism—the android with straight side walls and the flat type of pelvis (fig. 7 A and B). In the android pelvis resistance to anterior rotation is offered by the flat posterior pelvis. The presence of straight side walls indicates good transverse diameters throughout the lower pelvis. Lateral flexion removes the influence of the posterior pelvis and allows anterior rotation to occur on the inner aspects of the pubic rami or at a low level in the subpubic arch The act of anterior lateral flexion will frequently effect actual descent without the use of strong axis traction force. Barton forceps are used to illustrate this mechanism (fig. 7 C, D, and E). After anterior rotation has been accomplished, Barton forceps are removed and the delivery is terminated by the cephalic application of pelvic curved forceps (fig. 7 F).

In the classical flat pelvis the transverse oval at the inlet is preserved throughout lower levels by means of straight side walls and an average curvature and inclination to the sacrum (fig. 7 B). This transverse oval shape predisposes to a transverse mechanism throughout the pelvis, which becomes more important for ease in labour the greater the degree of flattening, provided the inlet admits the head. Less trauma to mother and child results if the head is made to descend to lower levels in the transverse position, as illustrated in fig. 7 C, D, E, and F.

The pelvis may show variable degrees and types of flattening. In the true flat pelvis the side walls do not converge and so the ischial spines are not prominent. Nor are they so in the normal pelvis with slight flattening, the so-called gynecoid-flat. The same mechanism occurs in the android-flat pelvis, but in this type there may be convergence of the side walls with increased prominence of the ischial spines. Prominent ischial spines may cause lateral sulcus tears in the vagina if the flattening of the inlet is sufficiently marked to prevent early anterior rotation of the head in an

effort to avoid the spines. Separation of the symphysis, stillbirth, a shocked infant, or serious injury to the maternal soft parts, has occurred from failure to maintain this transverse mechanism and from making premature attempts at anterior rotation in certain android and flat pelvic types.

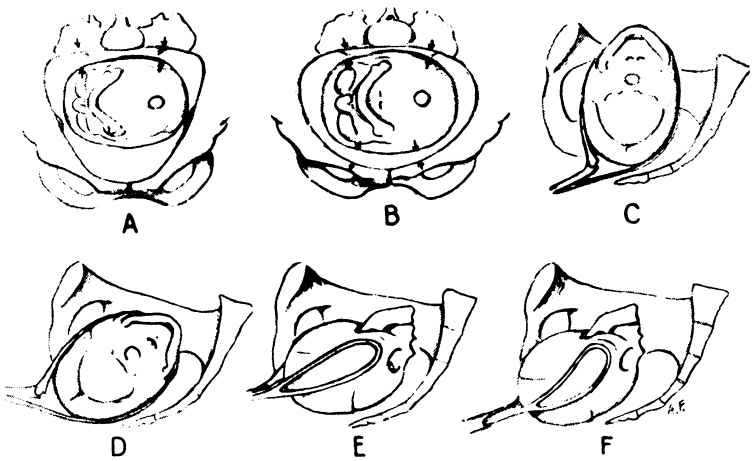


FIG. 7.—THE MECHANISM IN ANDROID TYPES WITH STRAIGHT SIDE WALLS, AND IN THE FLAT TYPE OF PELVIS

A. Anterior rotation is resisted by the opposing forces between the head and the flat posterior pelvis in certain android types.

B. Anterior rotation is resisted by opposing forces between the head and the posterior and anterior walls of the pelvis in flat forms.

C. Barton forceps applied to the head.

D. Descent with lateral flexion. The head follows the curve of the lower sacrum and coccyx.

E. Anterior rotation is effected at a low level on the inner aspects of the pubic rami or under the subpubic arch after the head has been deviated away from the influence of the posterior pelvis.

F. Barton forceps are removed and a cephalic application of pelvic curved forceps made for the low terminal delivery.

Table IX also shows that ease in anterior rotation in transverse arrests of the head usually indicates ample space in the antero-posterior diameter to allow this rotation. There is a decided decrease in flat types in the cases in which anterior rotation is accomplished by manual or instrumental rotation at the level of arrest.

This table also shows that anterior spiral rotation with descent is commonly associated with a particular type of android pelvis (fig. 8). The inlet in characteristic android types is wedge-shaped, because of the flat posterior pelvis and the narrow angle of the fore-pelvis behind the symphysis. There is also a definite degree of convergence, with prominent ischial spines and a narrow subpubic arch. Although architecturally the inlet cannot be considered flat, the antero-posterior diameter is usually under average in size and the narrow angle to the fore pelvis creates a flat space in the posterior pelvis through which the head descends. Thus transverse arrest at, or slightly below, the level of the ischial spines is likely to occur. In the operative delivery the shape of the upper pelvis acts to maintain this transverse position, while the changed shape of the mid-pelvis, caused by the narrow interspinous diameter, tends to encourage anterior rotation so that the head may make use of the compensatory space in the sagittal plane at this level. Further descent in the transverse position will bring the head into contact with the restricted interspinous diameter. The correct mechanism in the event of transverse arrest in this type, therefore, consists of anterior lateral flexion associated with spiral rotation and descent (fig. 8). In reality this mechanism consists of anterior lateral flexion, which deviates the head

toward the pubic rami and away from the posterior pelvis. After this position has been obtained, anterior rotation may be more easily carried out. Occasionally further descent in the transverse position must be carried out, when anterior rotation is prevented by the flat shape of the posterior pelvis at higher levels. As a result we have found several examples of android types with convergence of the side walls in which delivery was terminated by the use of Barton forceps. In these cases Barton forceps served to flex the head laterally in the transverse position into the fore-pelvis away from the influence of the posterior pelvis. The head descends to a lower level in the transverse position through the widest part of the anterior pelvis (intertuberous diameter) in front of the narrow interspinous diameter. Anterior rotation is accomplished according to the principle illustrated for the flat mechanism in fig. 7. The typical android pelvis (fig. 8) represents, in our experience, the only

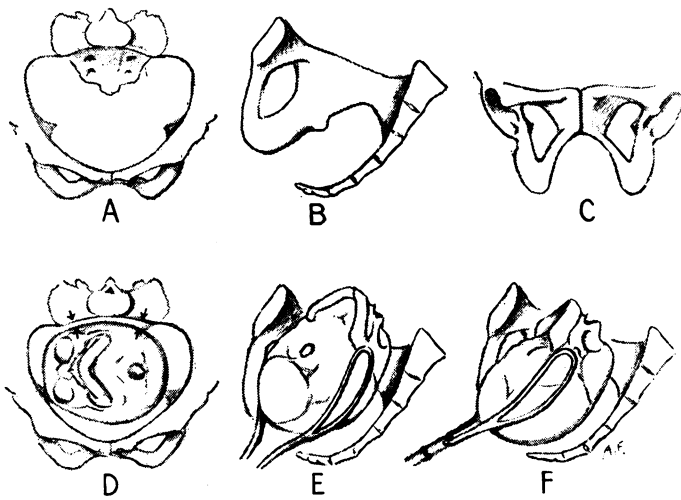


FIG. 8.—THE MECHANISM OF SPIRAL ANTERIOR ROTATION IN TYPICAL ANDROID TYPES

A. Inlet view to show the wedge-shaped inlet with converging side walls.

B. Lateral view to show the slightly restricted capacity in the posterior pelvis.

C. View of the narrow subpubic arch.

D. Transverse arrest of the head in mid-pelvis. The shape of the posterior pelvis prevents easy anterior rotation of the head. The narrow interspinous diameter with converging side walls below require anterior rotation, in order that the biparietal diameter may descend through the intertuberous diameter and the long axis of the head may adjust itself to the sagittal diameter.

E. Pelvic curved forceps effect partial rotation and carry the head away from the posterior pelvis by lateral flexion. With descent anterior rotation continues as the head moves downward and forward.

F. Anterior rotation is now completed with the vertex low on the pelvic floor.

type in which this spiral anterior rotation with descent is applicable. It is a mechanism which must be employed with care. Version and breech extraction has occasionally been used to effect delivery in similar cases. It is difficult to study the mechanism in this form of pelvis, because in our series such types have commonly been delivered by Cæsarean section.

The examples shown in fig. 7 illustrate the head close to the sacrum descending through the posterior pelvis (as in the low-medium or medium forceps *behind*, fig. 6 A). Other examples will be found in which the head descends through the fore pelvis close to the symphysis (as in the low-medium and the medium forceps *in front*, fig. 6 A). This type of fore pelvic arrest may occur in any type of pelvis which presents a flat surface to the lateral aspects of the fœtal head. The mechanism of delivery is shown

in fig. 9 in association with an android-gynecoid type of pelvis. The android-gynecoid type has compensatory space in the wide, well-formed fore pelvis. In the upper pelvis the shape of the posterior segment creates a transverse position. If the ischial spines are long and the interspinous diameter is slightly narrowed, the head not infrequently descends diagonally downward and forward to pass in front of the ischial spines and utilize the wide intertuberous diameter in the lower fore pelvis. The close approximation of the lateral aspects of the head to the well-formed fore pelvis helps to maintain a transverse position to a low level and resists manual attempts at anterior rotation. In the delivery an attempt must be made first to elevate and flex the head laterally away from the symphysis before anterior lateral flexion and anterior rotation may occur. By these manœuvres misdirected force against the pubic rami is avoided.

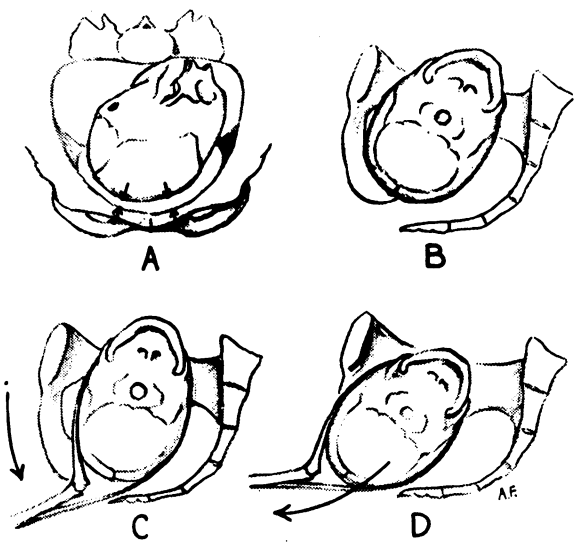


FIG. 9.—THE MECHANISM WITH ARREST IN THE FORE PELVIS CLOSE TO THE SYMPHYSIS AND DESCENDING PUBIC RAMI

A. Arrest in the fore pelvis in the transverse position in an android-gynecoid type. Anterior rotation is resisted by the flat surface of the fore pelvis. (The head may present close to the symphysis in any position.)

B. Lateral view with transverse position illustrated. The lateral side of the head tends to be close to the posterior aspects of the symphysis.

C. The head is dislodged upward and then slightly downward and backward by manual or instrumental methods.

D. By lateral flexion the head descends into the outlet and under the subpubic arch where anterior rotation is carried out.

Mid-pelvic arrest in the transverse position occurred in eight pelves of the anthropoid type. In six of these cases the ample antero-posterior diameter allowed anterior rotation at the level of arrest. This manœuvre is advisable in an effort to avoid forceful descent of the head in the transverse position through a transversely manœuvred pelvis. Occasionally this latter mechanism may be used if anterior rotation is resisted by the posterior pelvis or if the shape of the outlet favours descent of the head in the transverse position. However, in most instances, transverse arrest of the head in typical anthropoid types should not be delivered to lower levels in this position. Separation of the symphysis, with stillbirth, has occurred when such incorrect mechanical methods were used to effect delivery.

The method of delivery for the low-medium type of arrest in the transverse position and the type of pelvis commonly associated with each manœuvre is shown in Table X.

TABLE X.—DISTRIBUTION OF PELVIC TYPE ACCORDING TO THE MANŒUVRE USED IN DELIVERY IN LOW MID-PELVIC ARREST IN THE TRANSVERSE POSITION.
(29 *in* 100 *Cases of Low-mid Forceps.*)

							Platypelloid			
	Anthropoid	Anthropoid-gynecoid	Android-anthropoid	Android-gynecoid	Gynecoid	Android	Gynecoid-flat	Android-flat	True-flat	Number of cases
O.T. to floor (Barton forceps). Low rotation	0	0	0	0	2	2	2	4	2	12
Rotation to O.A. manually plus low forceps	0	0	0	1	2	5	1	0	1	10
Anterior rotation with forceps	0	0	0	1	3	0	1	1	1	7
								Total	..	29

It will be observed again that when low transverse arrest occurs in association with the flat type of pelvis, Barton forceps are used to effect lateral flexion and low rotation. Manual rotation to the anterior position is successful if the pelvis shows compensatory space in the antero-posterior diameter. Occasionally, even in flat types, arrest may occur at a very low level after partial anterior rotation has occurred spontaneously. In these examples a cephalic application of pelvic curved forceps is made to complete the rotation.

It is interesting to note that in no instance was low transverse arrest of the head found in any pelvis possessing an anthropoid or long oval shape. Low transverse arrest and its relationship to the flat pelvis is quite analogous to the low occipito-posterior arrest of the head in relation to the anthropoid type of pelvis.

(5c) *Posterior Arrests*

In 31 cases, out of 100 medium-forceps deliveries, the head was found in the occipito-posterior position, Table XI. In approximately one-half of these cases

TABLE XI.—DISTRIBUTION OF PELVIC TYPE ACCORDING TO THE MANŒUVRE USED IN THE DELIVERY IN MID-PELVIC ARREST IN THE OCCIPITO-POSTERIOR POSITION.
(31 *in* 100 *Cases of Mid-forceps Deliveries.*)

							Platypelloid			
	Anthropoid	Anthropoid-gynecoid	Android-anthropoid	Android-gynecoid	Gynecoid	Android	Gynecoid-flat	Android-flat	True-flat	Number of cases
Rotation to O.T. and descent to floor. Low rotation	3	0	3	2	1	4	1	2	0	16
O.P. to floor. Pelvic application	2	0	1	1	0	0	0	0	0	4
Face to pubis	1	0	0	0	0	0	0	0	0	1
Scanzoni at level of arrest	2	0	0	0	0	2	0	0	0	4
Manual rotation at level of arrest	0	0	0	0	1	0	0	1	0	2
Elevation with manual rotation	0	0	1	0	0	0	0	0	0	1
Spiral rotation with descent	0	0	0	0	0	2	0	0	0	2
Craniotomy	0	0	0	0	0	1	0	0	0	1
								Total	..	31

delivery was accomplished by manual rotation to the transverse position followed by the application of Barton forceps. By lateral flexion and traction the head

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Section of the History of Medicine

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William Gilbert (1544-1603), Robert Fludd (1574-1637), and William Harvey (1578-1657), as Medical Exponents of Baconian Doctrines

By H. P. BAYON, M.D., Ph.D.

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IT has been often stated that the experimental method of modern science obtained its initial impulse from Francis Bacon (1561–1626); but how this impulse acted has not been explained, for Bacon's scientific sterility contrasts with the actual contributions to mathematical knowledge made by René Descartes (1596–1650) who, moreover, illustrated reflex action by experiment and wrote an elementary treatise of physiology.

Bacon attempted to complete a comprehensive survey of all extant knowledge; his system was planned on a most generous scale and with a vast design. Both as a philosopher and a patient he was intensely interested in natural science and "physick," yet only some of his tenets were relevant to biology and medicine. Certain authors, e.g. B. W. Richardson (1900), have stated that Bacon influenced medical progress in its most advanced departments; while others, like Minkowski (1934) consider that Bacon made a grandiose attempt to study Nature and subjugate it to the needs and use of mankind. Broad (1926) pointed out that Bacon, though a most pertinacious experimenter was also a very incompetent one, and that he failed to recognize several scientific advances that were taking place in his time while credulously accepting an inchoate mass of superstitious beliefs.

That Bacon was anticipated in the practical application of the experimental method by William Gilbert is known; that Harvey gave a brilliant demonstration of experimental biology is also universally admitted; less recognized is the application of experiment in the explanation of pathological processes made by Robert Fludd, the "Mystical Physician".

It is the purpose of this essay to indicate how Gilbert, Fludd, and Harvey practised what Bacon preached and propounded in his many writings, and that therefore they succeeded in converting Bacon's words into deeds.

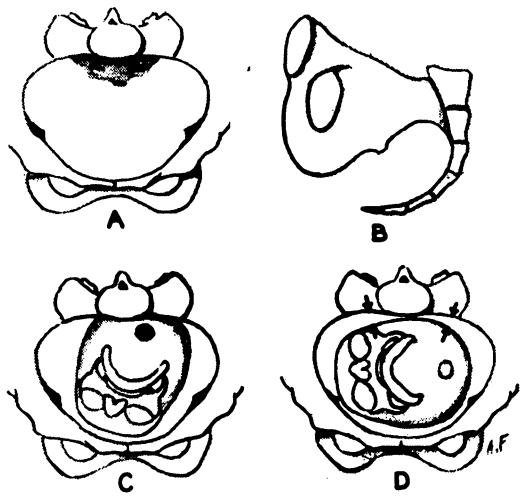

FIG. 11.—THE MECHANISM OF ARREST IN THE OCCIPITO-POSTERIOR POSITION IN FLAT TYPES WITH A BACKWARD SACRUM

A. Inlet view.

B. Lateral view to show the backward inclination to the sacrum with increased sacral concavity into which the occiput rotates.

C. Arrest in the occipito-posterior position in mid-pelvis.

D. As in the android type, fig. 10, the posterior pelvis prevents rotation of the ovoid head beyond the transverse position. From this position delivery is usually terminated by the use of Barton forceps as illustrated in fig. 7.

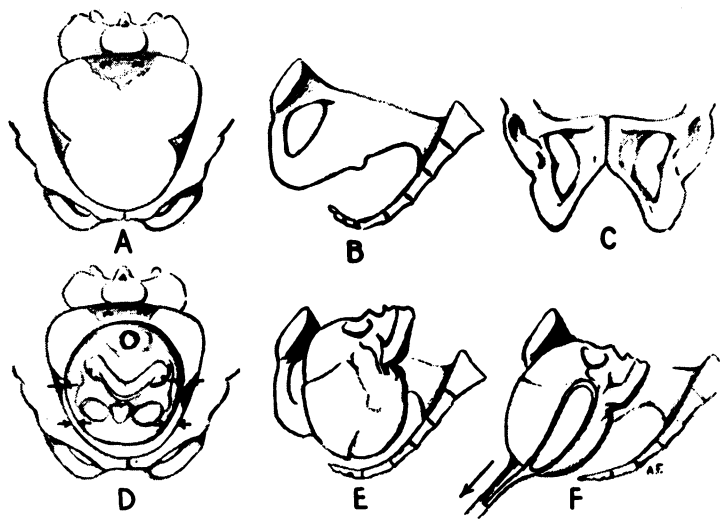

FIG. 12.—THE MECHANISM FOR DELIVERY FROM ARREST IN THE OCCIPITO-POSTERIOR POSITION TO LOWER LEVELS IN THE SAME POSITION

A. Android-anthropoid type of pelvis with a long antero-posterior diameter, prominent ischial spines, and converging side walls.

B. Lateral view to show ample posterior pelvic capacity because of an average curvature and inclination to the sacrum.

C. Antero-posterior view of the slightly narrowed subpubic arch.

D. Arrest in the occipito-posterior position—inlet view.

E. Arrest in the occipito-posterior position—lateral view.

F. A pelvic application of pelvic curved forceps is made and traction exerted downward and forward. A low complete rotation may be accomplished with caput in sight, or the head may be delivered occasionally face to pubis if the lower sacrum does not offer obstruction.

Manual rotation at the level of arrest was successful in one case with a normal pelvis. Elevation of the head with rotation at a higher level was also employed on one occasion in an android-anthropoid type. Spiral rotation with descent was employed in two android types. Craniotomy—through poor judgment—was performed in one instance.

Thoms [18] and others have drawn attention to the frequency of occurrence of the occipito-posterior position in the anthropoid pelvis. This observation, of course, is correct, but the anthropoid pelvis is an efficient pelvis, and there is usually spontaneous rotation or arrest in the occipito-posterior position at a low level with the caput in sight. A study of Table XI, however, indicates that in medium-forceps deliveries the arrested posterior position is found chiefly in android or in flat pelves. The long oval shape is present at the mid-pelvis, to encourage this position by the presence either of converging side walls in the android type or of a backward sacrum in the flat forms. This observation is important and stresses the value of a knowledge of pelvic shapes in the treatment of mid-pelvis arrest.

In the low-mid type with arrest of the head in sight or on the pelvic floor, however, we find that the occipito-posterior position becomes once more characteristic of the anthropoid pelvis, as shown in Table XII. 15 of the 22 cases showed extreme

TABLE XII.—DISTRIBUTION OF PELVIC TYPES ACCORDING TO THE MANŒUVRE USED IN THE DELIVERY OF LOW MEDIUM ARREST IN THE OCCIPITO-POSTERIOR POSITION.

(22 in 100 *Cases of Low-mid Forceps.*)

							Platypelloid			
	Anthropoid	Anthropoid-gynecoid	Android-anthropoid	Android-gynecoid	Gynecoid	Android	Gynecoid-flat	Android-flat	True-flat	Number of cases
Complete Scanzoni	5	0	0	0	0	1	0	0	0	6
Complete manual anterior rotation	2	1	0	2	0	1	0	0	0	6
Manual to O.T. plus Barton's	0	0	1	1	1	0	1	0	0	4
Face to pubis ..	0	0	1	0	0	0	0	0	0	1
Elevation with manual rotation	2	0	1	0	0	0	0	0	0	3
O.P. to lower levels. Low rotation	1	0	1	0	0	0	0	0	0	2
								Total ..		22

anthropoid tendencies with definite transverse narrowing throughout the pelvis. Descent of the head to the outlet usually implies good flexion and moulding ; accordingly, anterior rotation is much more easily carried out than it would be if arrest took place at a higher level. Complete forceps rotation (Scanzoni manœuvre) was performed six times at this low level of arrest, and in five instances the pelvis was anthropoid in shape. Elevation with manual rotation of the well-flexed and moulded head was successful three times in anthropoid types. The method used commonly in mid-pelvic arrest in the transverse position was used only four times in the 22 cases of the low-medium type, i.e. manual rotation to the transverse position, with application of forceps, lateral flexion and descent, with anterior rotation with the caput well in sight. Face-to-pubis delivery with forceps was easily accomplished in one case in which there was a marked android-anthropoid type with convergence.

In an extreme anthropoid type one stillbirth resulted after arrest had occurred with the caput in sight in the direct occipito-posterior position (fig. 13). The baby was injured by repeated attempts at anterior rotation. The successful manœuvre consisted in elevation of the head to the inlet with manual rotation. This particular patient has subsequently delivered an average-sized child, face-to-pubis, spontaneously, this fact indicating that in certain cases delivery by forceps, face-to-pubis, is justifiable.

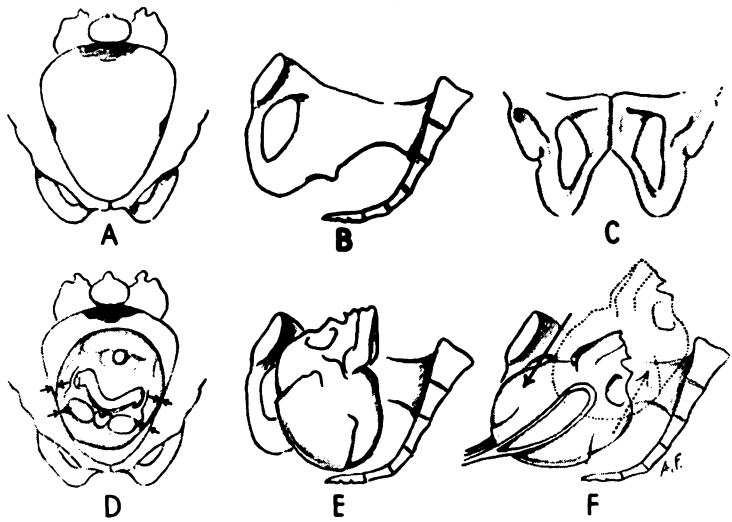

FIG. 13.—THE MECHANISM OF ELEVATION WITH HIGH MANUAL ROTATION OF THE OCCIPITO-POSTERIOR POSITION IN EXTREME ANTHROPOID TYPES

A. Inlet view showing a long antero-posterior with marked transverse narrowing through the pelvis.

B. Lateral view indicating a slightly forward lower sacrum.

C. Antero-posterior view of the narrow subpubic arch.

D. Arrest in the occipito-posterior position in the lower fore pelvis with caput in sight. Attempts at anterior rotation at the level of arrest were unsuccessful because of the restriction in transverse diameters. These attempts at rotation seriously injured the child, causing a stillbirth.

E. Lateral view of arrest in the occipito-posterior position.

F. Delivery was finally accomplished easily by elevation of the head toward the inlet followed by manual anterior rotation at this high level. The head rapidly descended to the outlet where forceps were applied.

(5D) *Anterior Arrests*

The type of pelvis associated with mid- and low-mid arrest in the anterior position is shown in Table XIII. The first point of interest is the absence of flat pelves in the medium-forceps group. This finding contrasts with that of occipito-posterior mid-pelvic arrest, in which the flat pelvis was occasionally noted in conjunction with a backward sacrum. The anterior position, however, as in the occipito-posterior arrest, is associated with two common architectural features, i.e. an ample antero-posterior diameter and converging side walls with a decrease in the interspinous diameter.

TABLE XIII.—DISTRIBUTION OF PELVIC TYPES IN ARREST IN THE ANTERIOR POSITION FOR MID- AND LOW-MID FORCEPS DELIVERIES.

(*From* 100 *Cases each of Mid and Low-mid Forceps.*)

							Platypelloid			
	Anthropoid	Anthropoid-gynecoid	Android-anthropoid	Android-gynecoid	Gynecoid	Android	Gynecoid-flat	Android-flat	True-flat	Number of cases
Mid-pelvic arrest in the anterior position delivered by cephalic-application of forceps	3	0	5	2	4	7	0	0	0	21
Low-mid arrests in the anterior position delivered by cephalic application of forceps	3	9	8	9	4	12	0	4	0	49

With arrest of the head in the anterior or the anterior oblique position a cephalic application of forceps is easily made and the degree of traction necessary to effect delivery is, to a certain extent, dependent upon the degree of convergence of the side walls. The widest biparietal diameter of the head descends through the intertuberous diameter in front of the narrowed interspinous diameter.

(5E) *The Pelvic Outlet as Influenced by Lower Sacral Variations*

Convergence of the side walls and variations in sacral curvature and inclination may effect a change in pelvic shape at and below the level of the ischial spines. The importance of convergence of the side walls has been repeatedly stressed in a discussion of the mechanism of forceps deliveries in the android and anthropoid types.

In the sagittal plane variations in the curvature and inclination of the sacrum affect the relationship of the lower sacrum and sacrococcygeal platform to the ischial spines and change the shape of the pelvic outlet (fig. 4 A, B, C). The frequency with which the forward sacrum was noted in the low-medium and medium forceps groups indicates the influence that restriction of posterior outlet space plays in pelvic arrest. An attempt has been made to illustrate the common types of lower sacral variation by the use of suitably chosen case studies.

In fig. 14 A, B, and C, the lower sacrum curved forward to a considerable degree below the level of the ischial spines. The long posterior sagittal diameter at the level

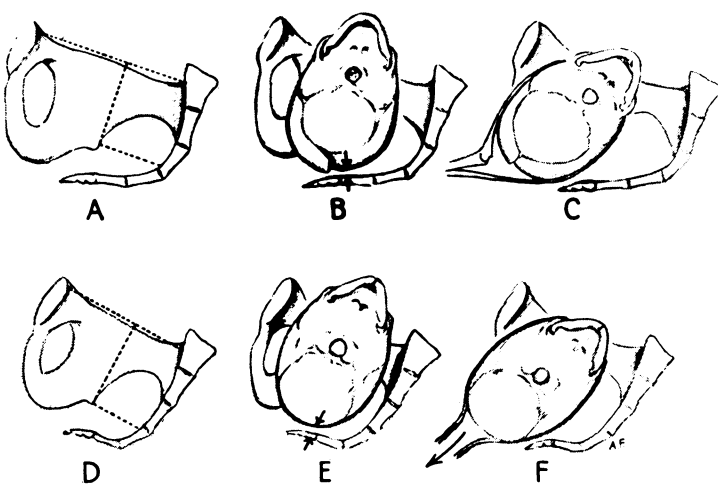

FIG. 14.—THE PELVIC OUTLET AS INFLUENCED BY SACRAL VARIATIONS

A. Lateral view of a large anthropoid pelvis with a forward lower sacrum. The posterior sagittal diameter at the level of the spines is long. The sacrococcygeal platform is elevated toward the level of the spines. The sacral tip and coccyx extends forward under the spines causing a short antero-posterior diameter at the outlet and a flat outlet shape.

B. Arrest of the head in the transverse position on the sacrococcygeal platform. The posterior parietal bone is depressed.

C. Barton forceps were easily applied. The head was flexed laterally toward the outlet and anterior rotation was accomplished after the biparietal diameter had passed the sacral tip.

D. Lateral view of an ample flat type of pelvis with good sacral concavity and forward lower sacral tip.

E. Arrest of the large head occurred on the sacrococcygeal platform close to the sacrum. The good sacral concavity allowed descent to this level.

F. Barton forceps brought the head close to the pubic rami by lateral flexion. With traction, force was misdirected against the symphysis. Barton forceps were removed and pelvic curved forceps were applied, in cephalic application. The head easily descended by downward and forward traction. Anterior rotation occurred after the biparietal diameter of the head had passed the sacral tip.

of the spines and the generally large pelvis allowed rapid descent until the head was arrested by the forward sacral tip. The shape of the outlet was converted into a flat transverse oval, which necessitated the delivery of the head to a lower level in the transverse position by forceps, as illustrated.

In the example shown in fig. 14 D, E, and F, a somewhat similar shape existed at the outlet. The pelvis conformed to a large flat type, which predisposes to a transverse arrest. The good sacral concavity and ample posterior sagittal diameter at the level of the spines allowed the head to descend to be arrested by the forward sacral tip. It was necessary to deliver the head in the transverse position through the fore pelvis until the biparietal diameter had passed the sacral tip before anterior rotation could be obtained. Barton forceps were used to flex the head laterally over the pelvic outlet close to the pubic rami. Barton forceps, however, failed to bring about descent, because force with traction was misdirected against the pubic rami. After a cephalic application was obtained by pelvic curved forceps, the correct downward and forward axis of traction was determined, and the head descended in the direction indicated in the diagram, fig. 14 D, E, and F.

The example shown in fig. 15 A, B, and C, reveals the significance of increased

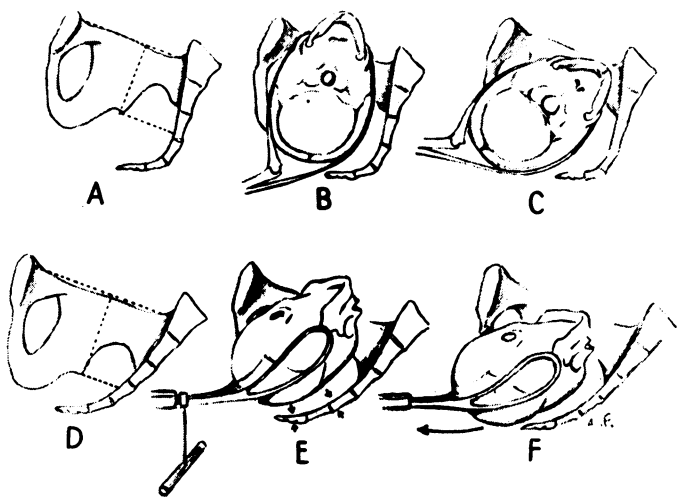

FIG. 15.—THE PELVIC OUTLET AS INFLUENCED BY SACRAL VARIATIONS

A. Lateral view of a flat android type of pelvis. The sacrum is straight with a slight backward inclination. The long posterior sagittal diameter at the level of the spines and the straight sacrum presented no obstruction to the descent of the head. Arrest occurred on the pelvic floor in the OP–OT position because the shape of the pelvis prevented anterior rotation.

B. Lateral view of the arrest, with Barton forceps applied.

C. Lateral flexion with forceps removed the influence of the posterior pelvis and allowed low anterior rotation.

D. Lateral view of an ample anthropoid type with a forward inclination to the sacrum.

E. Arrest occurred just above the pelvic floor in the oblique anterior position because of the forward sacrum. Haig Ferguson forceps were applied. A downward and backward traction caused no advance of the head because traction force was misdirected against the lower sacrum.

F. Elevation of the handles of the forceps caused slight extension of the head and with a downward and forward axis of traction descent occurred easily.

posterior outlet space caused by a straight sacrum with a slightly backward inclination. The pelvis, a flat android, allowed the head to descend in the ROT–ROP position until the posterior aspects of the perineum began to bulge. The shape of the pelvis prevented rotation, but the adequate posterior pelvic shape caused by the straight backward sacrum allowed this low descent. The patient was delivered by low forceps.

Barton forceps brought about anterior lateral flexion, and anterior rotation was easily accomplished with caput in sight.

The influence of the forward sacral inclination is shown in fig. 15 D, E, and F. The head was arrested in the direct antero-posterior position on the pelvic floor. Attempts at delivery with pelvic curved forceps failed when traction was exerted downward and backward. Force was misdirected against the forward sacrum. As soon as an attempt was made to extend the head, descent and an easy delivery occurred.

(6) Stillbirth and its Relationship to the Mechanism of Delivery

Sixteen stillbirths occurred in this series of 500 case studies. In addition four stillbirths occurred from delivery in other institutions. A detailed discussion of the factors in the maternal pelvis, the maternal soft parts, and the fœtus which contribute to the cause of the stillbirth is beyond the scope of this investigation. In three instances a larger second child was delivered spontaneously. In seven cases a major degree of disproportion existed in addition to the soft part dystocia or any incorrect axis of traction or forceful attempts at rotation. However, in nine cases, from the standpoint of pelvic shape, the mechanism used to effect delivery is open to question. Forceful attempts at anterior rotation in flat and android types represented the common errors in mechanism. We have already described the mechanism to be preferred in these types and have advised descent to the floor in the transverse position with low rotation (fig. 7). In one case-study, illustrated in fig. 13, the stillbirth was caused by forceful attempts at anterior rotation of an occipito-posterior position arrested with caput in sight in an extreme anthropoid type of pelvis with restriction in all transverse diameters. In order to illustrate more clearly the importance of using good mechanics in delivery in an effort to avoid injury to the child and the maternal soft parts, the following four case studies have been chosen.

I.—The pelvis conformed to the typical flat android type. Arrest occurred in mid-pelvis in the transverse position. The child was seriously injured by forceful attempts at anterior rotation with a poor cephalic application to the oblique anterior position. This type of pelvis favours the transverse mechanism illustrated in fig. 7. The second child was delivered spontaneously, weight 4,020 grm.

II.—(Not included in the series of 500 cases.) The pelvis conformed to the true platypelloid type. Forceful attempts at anterior rotation of an arrested transverse position caused a separation of the symphysis and a stillbirth. The second child was delivered by Cæsarean section. This pelvic type also favours the flat mechanism illustrated in fig. 7.

III.—The pelvis conformed to the typical android, with practically straight side walls. Arrest of a large child occurred in mid-pelvis in the transverse position with the cervix fully dilated. Weight of child, 3,856 grm. Forceful attempts were made to gain anterior rotation with pelvic curved forceps. The child died from intracranial hæmorrhage twelve hours after delivery. This type of pelvis favours the transverse mechanism illustrated in fig. 7.

IV.—The pelvis conforms to the typical extreme anthropoid with straight side walls and a moderate subpubic arch. Arrest occurred in low mid-pelvis in the occipito-posterior position. Forceful attempts at anterior rotation were used. With difficulty the head was rotated to the transverse position and delivered to lower levels in this position with Barton forceps. (This mechanism is obviously incorrect. The head should be elevated and rotated or brought to lower levels in the position of arrest.) The child weighed 3,610 grm., and was discharged living. It was badly shocked on delivery and suffered multiple fractures of the parietal bone.

These four cases, along with the example illustrated in fig. 13, stress the following principles in mechanism :—

(1) Forceful attempts at anterior rotation in flat and certain android pelvic types should not be made, or separation of the symphysis or stillbirth may result.

(2) The transverse mechanism to lower levels should be encouraged in these forms.

(3) Forceful attempts at anterior rotation in low occipito-posterior arrest in extreme anthropoid pelves are equally dangerous.

(4) The head should be elevated and rotated at a higher level or brought to a lower level in the occipito-posterior position and rotated or delivered face-to-pubis.

During the last two years at the Sloane Hospital for Women the attending staff have coöperated in the application of a knowledge of pelvic shape to the mechanism of labour. The incidence for Cæsarean section has not increased, because of the better selection of cases for this method of delivery. The incidence of difficult forceps deliveries has decreased, and there has been a definite decrease in the fœtal mortality, due, we believe, to the use of a better mechanism in forceps deliveries. The resident and interne staff, readily grasp, under instruction, the principles of mechanism described in this report. Recently in our clinic there has been renewed interest in the roentgenologic study of the pelvis and the fœtal-pelvic relationships of patients in labour who are not progressing normally. Frequently the recognition of a large head in a small pelvis has aided in the decision regarding the best method of delivery during the so-called trial of labour. If a forceps delivery later becomes necessary, the operator has an opportunity to attempt the mechanism he has interpreted as representing the optimum method for delivery from the study of the roentgenograms. As a result, greater conservatism in operative obstetrics has been practised.

ACKNOWLEDGMENTS

In conclusion, we wish to express our gratitude to Dr. B. P. Watson and the staff of the Sloane Hospital for Women, New York, for the co-operation extended during this investigation.

Illustrations.—Fig. 1 is reproduced by courtesy of the *American Journal of Roentgenology* and Messrs. Thomas Nelson and Sons, and fig. 2 also by courtesy of Messrs. Nelson.

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Discussion.—Professor F. J. BROWNE said that the four types of pelvis described by Dr. Moloy were only rarely found—gradations between them being numerous. The gynecoid pelvis was rare and almost always there were slight abnormal characters—such as some acute angulation of the fore-pelvis, or slight narrowing of the sacro-sciatic notch—indicating male tendencies. Dr. Moloy had emphasized the influence of the pelvic architecture on presentation and position of the fœtus and on the mechanism of labour, and there was no doubt it had an important bearing on these points but it could not be the sole influence, since it was repeatedly found that whereas in a first pregnancy and labour the fœtus might occupy a posterior position, perhaps giving rise to difficult labour, during the next pregnancy the position would be anterior and the labour easy. He thought too that the relative frequency of the four types of pelvis described by Dr. Moloy would be found to differ materially in England and America—an impression which had been borne out by results of investigations in London. Dr. Moloy had made no mention of the generally contracted pelvis, which was a very frequent cause of difficult labour in London. The work of Dr. Caldwell and Dr. Moloy had resulted in a great simplification and rationalization of the classification of contracted pelvis and was, he believed, destined to have a far-reaching influence on the teaching and practice of the future.

Professor MUNRO KERR said that Dr. Moloy had shown how, in pre-partum and intra-partum radiography a new method was to hand for the study of (*a*) the mechanism of labour; (*b*) the variations in movements which the head underwent when the pelvic formation differed from the female type. Obviously if wisely employed such information might be of great value in determining, before or during labour, the most suitable procedure to employ in a particular case. But the information furnished by this new method of examination must be used wisely and in conjunction with the other recognized methods of examination which had been employed up to the present.

It was satisfactory to learn that the exact observations which Dr. Moloy and his colleagues had carried out had not lessened the employment of "conservative methods" of delivery. The rates for forceps delivery and for "Cæsarean section" had not increased in the clinics in which these obstetricians had worked; on the contrary they had fallen. Members had just heard arguments in justification of "higher obstetrics" in which the subtleties of finesse were introduced into the practice of obstetrics, and surely these were stimulating.

There was, however, one point to which he thought Dr. Moloy should have referred, namely the influence exerted by the position of the back and shoulders of the child. While undoubtedly the formation of the pelvis affected position, flexion, extension, and rotation of the child's head, so also did the position of its back and shoulders. Radiographic examination must be utilized to correlate the influence which each and all of these factors exerted. Lastly he would stress the value of symphysiotomy and pubiotomy in the treatment of certain cases of malrotation and arrest of the head at the pelvic outlet.

Professor PRESTON MAXWELL said that in the cases with which he and his colleagues had to deal in Peiping, it was a matter of considerable difficulty to decide into what class pelves should be placed.

He questioned whether sufficient stress had been laid by Dr. Moloy and the workers to whom he had referred on the influence of rickets—even of mild degree—on the shape of these pelves and especially of those classified as "platypelloid".

Professor CHASSAR MOIR said he wondered whether Dr. Moloy thought that any useful purpose was served by continuing to teach students the meaning (or supposed meaning) of the terms "rickety", "flat", "simple flat", and "generally contracted" (justo-minor) pelvis. If the slate could be wiped clean and Dr. Moloy was empowered to rewrite this chapter of obstetrics, would he reintroduce these terms?

He understood that Dr. Moloy had recently been determining the circular area of the various planes of the pelvis and comparing these with the area of the cross-section of the fœtal head. He (Professor Moir) had also been working on this idea. By use of the Thoms's method of X-ray pelvimetry an outline of the brim of the pelvis, corrected for distortion and accurate in size, could be drawn in chart form. By lateral pelvimetry the length of the shortest diameter of the fœtal

head could also be obtained. A circle of this diameter was superimposed on the chart over the outline of the pelvic brim and a useful impression could then be obtained of the available space in the pelvis. Such a study referred to the brim only, but by clinical observation and by the help of lateral pelvimetry a useful knowledge could be obtained of the architecture of the lower portion of the pelvis. Dr. Moloy was able to make such observations more fully and accurately with his special " transparent " stereoscope, and this work was likely to become increasingly important. Meanwhile, the method just described gave information of considerable value which could not be easily obtained by any other simple non-stereoscopic examination.

Dr. CLARK NICHOLSON said that his criticisms of Dr. Moloy's paper were based on radiological measurements on more than 350 cases in a cottage hospital. He thought that Dr. Moloy had made too little mention of racial differences in the pelvis. The late Sir William Turner had pointed out that the Western European races were predominantly platypellic—i.e. had a pelvic index of less than 90, and his (Dr. Nicholson's) own series showed an average pelvic index of 88, suggesting that nearly 50% of the women of rural England had a pelvis of distinctly flattened type. On the other hand, the yellow and the negroid races were mesatipellic, and the more primitive races were dolichopellic, with a pelvic index of more than 95—the anthropoid type of Dr. Moloy. Did the bush people of Australia with this type of pelvis experience more than the usual proportion of difficulty in labour ? He (the speaker) thought that a classification of the pelvis which depended solely on appearances, and not on accurate measurements, was not truly scientific and could not be of permanent value in obstetrics. His figures tended to show that there was no close relationship between the shape of the pelvis and difficulty in labour.

Dr. MOLOY (in reply) : We have found that with care, considerable accuracy can be attained by clinical examination. At any rate distinctly abnormal cases can be recognized and referred for a complete roentgenologic examination. The terms *generally contracted pelvis*, *funnel pelvis*, and allied terms, inadequately describe the shape of the pelvis and hence should be replaced by a more accurate terminology. Dr. Nicholson has made use of the pelvic index and the three types described by Sir William Turner, in his roentgenologic studies. The lantern slides show clearly that pelvic shape at the inlet cannot be accurately determined by the ratio between the true conjugate and the widest transverse diameter. It is true that this ratio may show the long oval, the round, or the flat tendency, accurately enough for racial studies, but the important android or wedge-shaped type cannot be recognized by this method. For instance the pelvis with a platypellic index may be a true flat type or a classical android form. The well-formed flat pelvis is more efficient than the android with the same length to the true conjugate diameter. As a result, a description of the morphology of the pelvis, in conjunction with a record of the length of the cardinal pelvic diameters—as obtained by any method of roentgen-pelvimetry—represents essential steps in the study of the mechanism of labour.